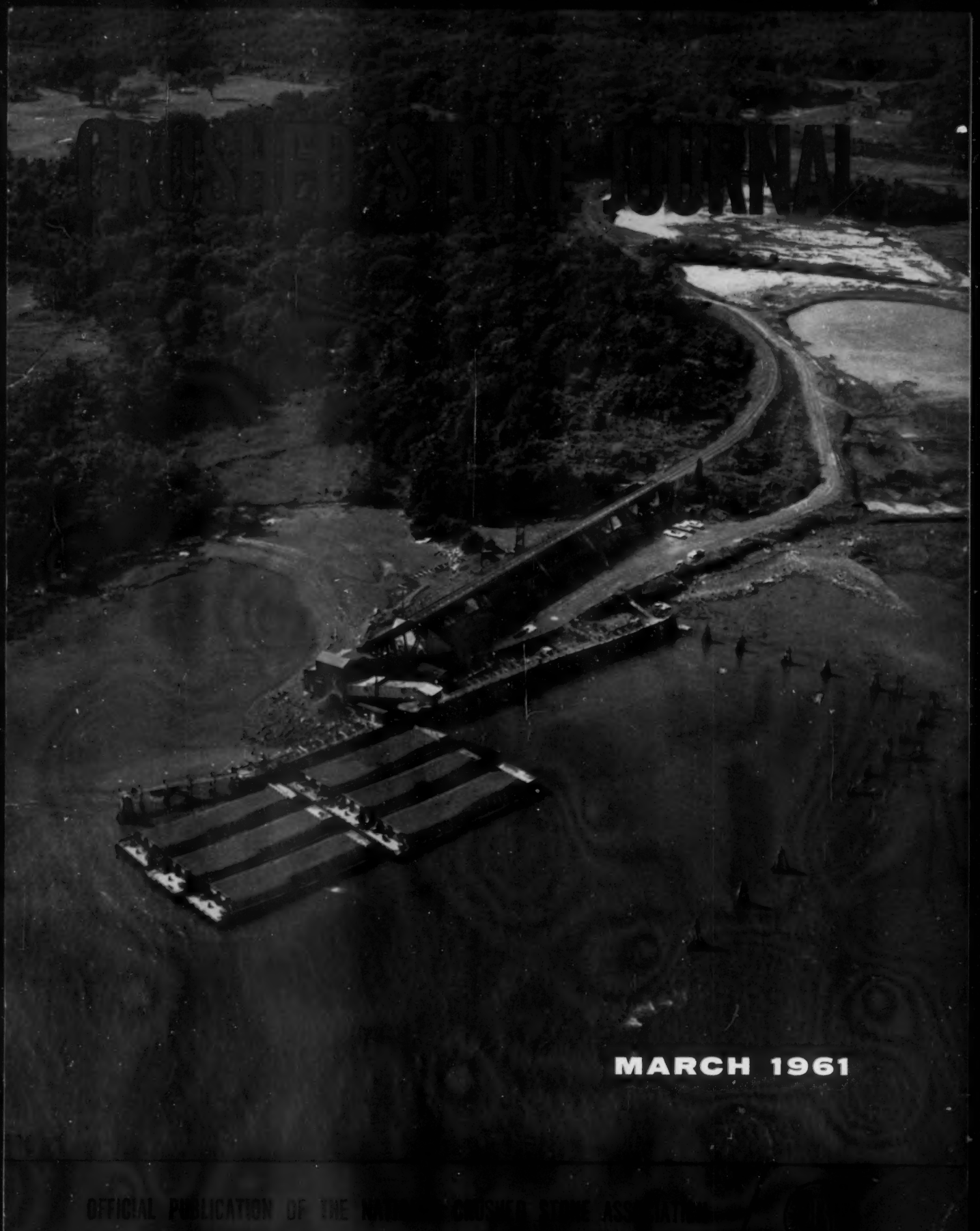

MARCH 1961

OFFICIAL PUBLICATION OF THE

PLAN TO ATTEND . . .

45TH ANNUAL CONVENTION

AND

MANUFACTURERS DIVISION EXPOSITION

National Crushed Stone Association

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CONRAD HILTON HOTEL

CHICAGO, ILLINOIS

•

February 12-13-14, 1962

"The Key to Progress"

Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

VOL. XXXVI No. 1 PUBLISHED QUARTERLY March 1961

NATIONAL CRUSHED STONE ASSOCIATION

1415 Elliot Place, N. W.
Washington 7, D. C.

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J. R. BOYD

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By Erskine Stewart 19

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Cover Photograph—Pine Orchard Dock of the New Haven Trap Rock Co., New Haven, Connecticut.

Credit—Photo by Earl Colter

CHARLES COBURN

President
Waukesha Lime & Stone Co., Inc.
Waukesha, Wis.

•

Elected President

NATIONAL CRUSHED STONE ASSOCIATION

by its Board of Directors

Miami Beach, Fla.

January 16, 1961

DARRELL SMITH

Manager Distributor Sales
Mining and Construction Division
Joy Manufacturing Co.
Pittsburgh, Pa.

•

Elected Chairman

MANUFACTURERS DIVISION

by its Board of Directors

Miami Beach, Fla.

January 16, 1961

44th Annual Convention Outstanding Success

Charles Coburn Elected NCSA President
Darrell Smith Heads Manufacturers Division

CRUSHED stone producers, manufacturers, and guests from all parts of the United States and Canada were in attendance at the 44th Annual Convention of the National Crushed Stone Association, held at the Americana, Miami Beach, Florida, on January 17, 18, 19, and 20, 1961.

The excellent attendance enjoyed by each of the Convention sessions was convincing evidence of the broad interest in the wide variety of subjects on the Convention program. Interest was sustained throughout these sessions by the timeliness of the subjects presented by particularly well qualified speakers. Much time and effort must of necessity go into the development of the Convention program and the outstanding success of the recent Miami Beach meeting is due, in large measure, to the painstaking efforts of the Convention Arrangements Committee under the capable Chairmanship of Charles Coburn.

Three gracious and charming hostesses, Mrs. G. D. Lott, Mrs. Charles Coburn, and Mrs. Clarence Camp, II, were on hand to greet the large number of ladies who were in attendance at the Convention. The ladies found much of appeal in their special program which included coffee hours, teas, and recreational activities in addition to the several NCSA luncheons and social functions on the regular Convention program.

From early morning until late evening those in attendance took advantage of the unequalled opportunity presented by the Convention to discuss individual problems and those of the industry

NCSA Greeting Luncheon, Tuesday, January 17, 1961, Medallion Room, Americana, Miami Beach, Florida

CHARLES COBURN
Waukesha Lime & Stone Co., Inc.
Waukesha, Wis.
President
National Crushed Stone Association

W. P. FOSS
New York Trap Rock Corp.
West Nyack, N. Y.
Vice President
National Crushed Stone Association

G. D. LOTT, JR.
Palmetto Quarries Co.
Columbia, S. C.
Immediate Past President

W. C. ROWE
Rowe Contracting Co.
Malden, Mass.
Elected Past President

EXECUTIVE COMMITTEE

of the

NATIONAL CRUSHED STONE ASSOCIATION

for 1961

ARTHUR GOFF
Wallace Stone Co.
Bay Port, Mich.

J. H. GROVE
M. J. Grove Lime Co.
Frederick, Md.

D. C. HARPER
Southwest Stone Co.
Dallas, Texas

J. L. HOLDEN
Genesee Stone Products Corp.
Batavia, N. Y.

M. E. MCLEAN
East St. Louis Stone Co.
East St. Louis, Ill.

W. D. MILNE
Kentucky Stone Co.
Louisville, Ky.

C. D. SMITH
Joy Manufacturing Co.
Pittsburgh, Pa.
Chairman
Manufacturers Division

with other producers and the nationally known authorities on the action packed Convention program.

Charles Coburn Elected President of NCSA

The first meeting of the new NCSA Board of Directors, elected by mail ballot prior to the Convention, was held Monday afternoon, January 16, 1961. At this time, in accordance with the By-Laws, the Board elected the Officers and Executive Committee for the ensuing year. Charles Coburn, President of the Waukesha Lime and Stone Company of Waukesha, Wisconsin, was unanimously elected President of the National Crushed Stone Association for the year 1961. In expressing his appreciation, Mr. Coburn thanked the Board of Directors for their confidence and pledged his effort to further the purposes and aims of the National Crushed Stone Association in every way possible. Other officers elected were as follows: Vice President, W. P. Foss, President, New York Trap Rock Corporation, West Nyack, New York; Treasurer, J. R. Callanan, President, Callanan Road Improvement Company, South Bethlehem, New York; Secretary, J. R. Boyd, Executive Director, National Crushed Stone Association, Washington, D. C. Photographs of the nine Regional Vice Presidents, elected by mail ballot prior to the Annual Convention, and the area each represents, appear on page —.

Election of Executive Committee

From the past Presidents eligible to serve on the Executive Committee, W. C. Rowe, Treasurer, Rowe Contracting Company, Malden, Massachusetts, was elected for the year 1961.

NEWLY ELECTED TO NCSA BOARD

J. Fred Coleman, Jr.
Bradford Hills Quarry, Inc.
East Petersburg, Pa.

J. W. Moffat
Inland Lime and Stone Co.
Division of Inland Steel Co.
Manistique, Mich.

From the elected members of the Board of Directors eligible to serve on the Executive Committee, the following were unanimously elected for the year 1961: Arthur Goff, President, Wallace Stone Company, Bay Port, Michigan; J. H. Grove, Vice President, M. J. Grove Lime Company, Lime Kiln, Maryland; D. C. Harper, President, Southwest Stone Company, Dallas, Texas; J. L. Holden, Vice President, Genesee Stone Products Company, Batavia, New York; M. E. McLean, President, East St. Louis Stone Company, East St. Louis, Illinois; W. D. Milne, President, Kentucky Stone Company, Louisville, Kentucky.

In addition to the elected members, the President, Vice President, and Immediate Past President of the Association, and the Chairman of the Manufacturers Division, serve as ex officio members of the Executive Committee. The entire Executive Committee, including the elected and ex officio members, is as follows:

NCSA Board of Directors Meeting, January 16, 1961

Regional Vice Presidents for 1961
National Crushed Stone Association

ABNEY BOXLEY
Southeastern
Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Virginia

A. N. FOLEY
New England
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont

D. C. HARPER
Southwestern
Arizona, Arkansas, Louisiana, New Mexico, Oklahoma, Texas

R. G. L. HARSTONE
British Commonwealth
Dominion of Canada, United Kingdom, Australia, New Zealand, Union of South Africa

J. W. MOFFAT
Northern
Michigan, Minnesota, Montana, Nebraska, North Dakota, South Dakota, Wisconsin

J. L. HOLDEN
Eastern
Delaware, Maryland, New Jersey, New York, Pennsylvania, District of Columbia

M. E. McLEAN
Midwestern
Illinois, Indiana, Iowa, Kansas, Missouri

A. W. McTHENIA
Central
Kentucky, Ohio, Tennessee, West Virginia

B. G. WOOLPERT
Western
Alaska, California, Colorado, Hawaii, Idaho, Nevada, Oregon, Utah, Washington, Wyoming

NCSA Executive Committee

Charles Coburn, Chairman

W. P. Foss	G. D. Lott, Jr.
Arthur Goff	M. E. McLean
J. H. Grove	W. D. Milne
D. C. Harper	W. C. Rowe
J. L. Holden	Darrell Smith

Election of Honorary Board Members

Unanimously elected as Honorary Members of the Board of Directors of the National Crushed Stone Association were: W. N. Carter, Joliet, Illinois; H. A. Clark, Chicago, Illinois; S. P. Moore, Cedar Rapids, Iowa; H. E. Rodes, Nashville, Tennessee; O. M. Stull, Buchanan, Virginia; and Stirling Tomkins, West Nyack, New York.

Manufacturers Division Elected Darrell Smith Chairman

The first meeting of the new Board of Directors of the Manufacturers Division of the National Crushed Stone Association, elected by mail ballot prior to the Annual Convention, was held Monday morning, January 16, 1961. At this meeting the following officers and members of the Executive Committee were elected and will serve for the year 1961: Darrell Smith, Manager, Distributor Sales, Mining and Construction Division, Joy Manufacturing Company, Pittsburgh, Pennsylvania, was unanimously elected Chairman, and L. A. Rhodes, Manager of Machinery Division, Stedman Foundry and Machine Company, Incorporated, Aurora, Indiana, was unanimously elected Vice Chairman.

Officers and Members of Manufacturers Division Executive Committee

Past Chairmen Manufacturers Division

Standing left to right: W. E. Collins, Jr., '59-60; Cottrell Farrell, '48-49; *Seated left to right:* L. A. Eiben, '57-58; B. R. Maloney, '54-55; Milo Nice, '44-45; J. C. McLanahan, '50-51; Wayne W. King, '56-57; I. F. Deister, '52-53.

Manufacturers Division Luncheon, January 19, 1961

C. D. SMITH
Joy Mfg. Co.
Pittsburgh, Pa.
Chairman
Manufacturers Division

L. A. RHODES
Stedman Foundry & Machine Co., Inc.
Aurora, Ind.
Vice Chairman
Manufacturers Division

EXECUTIVE COMMITTEE

of the

MANUFACTURERS DIVISION

National Crushed Stone Association

for 1961

G. D. FRAUNFELDER
Easton Car and
Construction Co.
Easton, Pa.
Immediate Past
Chairman

W. E. COLLINS, JR.
Atlas Powder Co.
Wilmington, Del.
Elected Past
Chairman

F. E. BRIBER, JR.
Allis-Chalmers
Mfg. Co.
Milwaukee, Wis.

J. W. HARDESTY
Baldwin-Lima-
Hamilton Corp.
Construction
Equipment Div.
Lima, Ohio

CHARLES COBURN
Waukesha Lime &
Stone Co., Inc.
Waukesha, Wis.
President
National Crushed
Stone Association

Election of Manufacturers Division Executive Committee

From the eligible past Chairmen, W. E. Collins, Jr., Assistant Vice President and General Manager, Explosives Division, Atlas Powder Company, Wilmington, Delaware, was elected to serve on the Executive Committee of the Manufacturers Division for the year 1961. From the eligible elected members of the Board of Directors the following were unanimously elected to serve on the Executive Committee: F. E. Briber, Jr., Assistant Manager, Processing Machinery Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin; and J. W. Hardesty, General Manager of Sales, Baldwin-Lima-Hamilton Corporation, Construction Equipment Division, Lima, Ohio.

In addition to the elected members of the Executive Committee, the Chairman, Vice Chairman, and Immediate Past Chairman of the Division, and the President of NCSA are ex officio members.

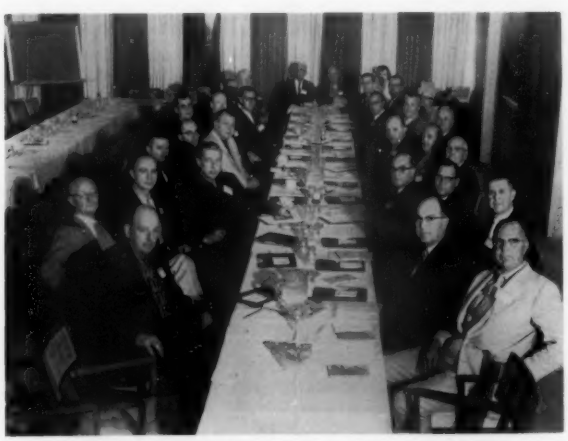
The entire Executive Committee, including elected and ex officio members is as follows:

Manufacturers Division Executive Committee

Darrell Smith, Chairman

F. E. Briber, Jr.	G. D. Fraunfelder
Charles Coburn	J. W. Hardesty
W. E. Collins, Jr.	L. A. Rhodes

On Wednesday evening, January 18, the Manufacturers Division held a reception for the newly elected Board members and for the new members of the Division.



Manufacturers Division Board of Directors Meeting February 16, 1961

NEWLY ELECTED TO NCSA MANUFACTURERS DIVISION BOARD

J. W. Bloomquist
Euclid Division
General Motors Corp.
Cleveland, Ohio

H. J. Douglas
Pennsylvania
Crusher Division
Bath Iron Works Corp.
West Chester, Pa.

E. E. Haupt
B. F. Goodrich
Industrial Products Co.
Akron, Ohio

C. E. Killebrew
Clark Equipment Co.
Construction
Machinery Division
Benton Harbor, Mich.

J. C. P. Taylor
Jeffrey Mfg. Co.
Pulverizer &
Crusher Division
Columbus, Ohio

Highlights of the Convention Program

The wide variety of subjects on the Convention program made this annual meeting particularly appealing to men involved in all phases of the crushed stone industry. In addition to the regular Convention program those in attendance benefited greatly from the fresh viewpoints which were gained through the exchange of ideas with fellow producers and members of the Manufacturers Division. Most certainly, this opportunity to discuss the difficult technical problems which inevitably arise in any quarry operation makes attendance at an NCSA Annual Convention worthwhile in itself.

The opening General Session on Tuesday, January 17, was called to order by NCSA President Lott who extended a warm welcome to the assembled group, and some of the highlights of the Association's activities during 1960 were summarized by members of the NCSA Executive Staff. Dr. Leonard Obert, Chief of the Applied Physics Laboratory, U. S. Bureau of Mines, was the final speaker of the session and presented recent developments in the Bureau of Mines' pro-

NCSA Safety Contest Winners 1959

Front Row, *left to right:* R. H. CHISHOLM, Carbon Limestone Co.; GRANT RUSSELL, Eastern Rock Products, Inc.; G. C. LARKIN, Standard Lime & Cement Co., Div. of American-Marietta Co.; H. P. JONES, General Crushed Stone Co.; CLAY LAMBERT, Consumers Co., Div. of Vulcan Materials Co.; J. L. LINDLER, Palmetto Quarries Co.; HENRY PATRICK, Catskill Mountain Stone Corp.; G. O. FOSTER, New York Trap Rock Corp.; J. W. MOFFAT, Inland Lime & Stone Co., Div. Inland Steel Co.; **Second Row**, *left to right:* W. H. MCGEE, Pounding Mill Quarry Corp.; T. J. STEWART, Houdaille Construction Materials, Inc., Div. Houdaille Industries, Inc.; CHARLES GRAY, SR., Eastern Rock Products, Inc.; J. F. COLEMAN, Bradford Hills Quarry, Inc.; RAY VENCILL, Kentucky Stone Co.; HAROLD CESSFORD, Weaver Construction Co.; F. C. PHILLIPS, National Lime & Stone Co.; CHARLES DAYHUFF, Southeastern Stone Co.; **Third Row**, *left to right:* JOHN JORGENSEN, New York Trap Rock Corp.; GLEN WYATT, W. E. Graham & Sons Div. of Vulcan Materials Co.; MERL PRICE, General Crushed Stone Co.; R. G. BUHS, Federal Materials Co.; A. L. VAN VALKENBURG, General Crushed Stone Co.; BURR SHAVER, General Crushed Stone Co.; LEON LEWIS, Catskill Mountain Stone Corp.; W. E. SCHMIDT, Columbia Quarry Co.; **Top Row**, *left to right:* J. H. GRAHAM, W. E. Graham & Sons, Div. of Vulcan Materials Co.; W. T. RAGLAND, Superior Stone Co. Div., American-Marietta Co.; J. M. LAMBERT, Lambert Bros. Div., Vulcan Materials Co.; J. P. COX, General Crushed Stone Co.; J. P. CIVIAL, JR., General Crushed Stone Co.; GEORGE WHITE, New York Trap Rock Corp.; J. O. LEONARD, Marble Cliff Quarries Co.; T. W. JONES, New Haven Trap Rock Co.; MELVIN HJELTNESS, B & M Crushed Stone Corp.

gram to revise their publication entitled "Seismic Effects of Quarry Blasting," better known as Bulletin 442. Dr. Obert's address appears in this issue of the *Crushed Stone Journal.*

Greeting Luncheon

The traditional Greeting Luncheon proved to be a memorable occasion. The new officers and Executive Committee of the National Crushed Stone Association were introduced and James Westfield, Assistant Director, Health and Safety, U. S. Bureau of Mines, Washington, D. C., presented the 59 winners of the NCSA Safety Contest with their attractive awards. In addition, immediately following this presentation of awards, Dr. Pierce Harris, Pastor of the First Methodist Church, Atlanta, Georgia, gave a pointed yet humorous talk on "A Working Creed for a Changing World."

Tuesday evening was the occasion for an informal Social Hour, which provided everyone with a wonderful opportunity to become better acquainted.

Session for Salesmen

The special Session for Salesmen consisted of a symposium on the Salesman's Role in the Crushed Stone Industry. Taking cognizance of the fact that today, in addition to possessing a thorough knowledge of his product, the salesman must often play an important role in other activities of his company. The speakers discussed in some detail what is expected of salesmen in various company situations. This session proved very timely and was well attended by those involved in this phase of the crushed stone industry.

G. C. Larkin, right, 1959 winner of the Explosives Engineer Award, being presented by James Westfield

The winner of the Explosives Engineer Award in the 1959 National Crushed Stone Association Safety Contest is the Kimballton Mine of the Standard Lime and Cement Company, Div. of American-Marietta, in Kimballton, Virginia. MR. G. C. LARKIN, Superintendent, is shown at right receiving the coveted award from MR. JAMES WESTFIELD, Assistant Director, Health and Safety, U. S. Bureau of Mines. The Kimballton Mine operated a total of 2,663 days from September 16, 1952, through December 31, 1959, without a lost time disabling work injury.

Round Table on Policies and Procedures for Maintenance and Repair of Fixed Equipment

Session for Operating Men

There were two sessions for Operating Men and Equipment Manufacturers, the first featuring an interesting and informative panel discussion in addition to several talks. The second was a repeat of the extremely successful "Round Table" discussions which was so popular two years ago. Ten subjects, each chosen for its timeliness and importance, were discussed at different tables where discussion leaders helped participants seek the answers. This session continued throughout the morning, permitting those in attendance to select and actually participate in as many discussions as their interest dictated.

General Luncheon

James C. Buchanan, Latin American Correspondent, Miami Herald, Miami, Florida, was the featured speaker at Wednesday's General Luncheon. His thought provoking and considered comments regarding "Cuba—Island in Crisis" proved to confirm the suspicions of many regarding Premier Castro's political convictions as well as to inform those in attendance that the United States Government is not completely oblivious to this critical situation.

Session for Executives

John F. Lane, General Counsel for NCSA, presided over two Sessions for Executives and Finance Officers. Tax problems of current interest, including Percentage Depletion, Depreciation, and Business Entertainment Expense, were delved into at length in the first session, and a thoughtful discussion of the various federal labor standards statutes, including Wage Hour, Walsh-

Round Table on Rubber Tired Equipment in Quarry Operations

Round Table on Drilling

Round Table on Accident Prevention

Healey, and Davis-Bacon Acts, at the second. Federal labor standards statutes are of particular importance to quarry operators because of their frequently overlapping impact on the work force of the crushed stone industry.

Manufacturers Division Luncheon

The Manufacturers Division had their annual Manufacturers Division Luncheon on Thursday, January 19. At this traditional and important affair the newly elected Officers and Executive Committee of the Division were introduced and brief reports on matters of importance to the members were given.

On behalf of the entire Manufacturers Division, the retiring Chairman of the Division, George Fraunfelder, was presented with a plaque in appreciation of his service to the Manufacturers Division of the National Crushed Stone Association. The plaque is inscribed as follows:

For Distinguished Service

GEORGE D. FRAUNFELDER
Chairman 1960
Manufacturers Division
National Crushed Stone Association

Mr. Fraunfelder expressed his deep appreciation for the help and many courtesies he had received throughout his term of office from the Officers, Board, Committees, and members.

Hostesses for Ladies Entertainment: Mrs. Charles Colburn, Mrs. G. D. Lott, Jr., Mrs. Clarence Camp, II

NCSA Party

The NCSA Party on Thursday night, January 19, had for a theme "A Night in the Tropics." This delightful affair was held in the beautiful, newly refurbished Grand Ballroom of the Americana. Throughout the evening the tropical theme prevailed with NCSA members and guests wearing straw hats and completely enjoying the evening of fun and relaxation. Delicious food, cooked by the excellent chef of the Americana, was in abundance and served buffet style from palm thatched huts strategically located around the room.

(Continued on Page 23)

Ladies Luncheon, January 19, 1961

Recent Developments of Bureau of Mines Investigation of Vibrations From Quarry Blasting[1]

By DR. LEONARD OBERT
Chief
Applied Physics Research Laboratory
Bureau of Mines
College Park, Maryland

A previous report[2] presented the Bureau of Mines-Industry program for studying the seismic effects from quarry blasting in which the principal objectives were:

1. The determination of a propagation law; that is at the point of measurement, the relationship between:
   a. Quantity of explosive
   b. Distance from the shot to the measuring point
   c. Magnitude of the seismic effect (displacement, acceleration, etc.)
2. The establishment of damage criteria; that is, the relationships between:
   a. Magnitude of a seismic effect
   b. Damage produced in a given type of structure

It was pointed out that this information is needed not only as a guide for quarry operators but by the various states that are preparing blasting codes so that such legislation does not become too restrictive. It was estimated that about 5 years would be required to complete this program.

The present report discusses the progress that has been made during 1960. This progress includes the following items:

1. An evaluation of the previous damage criteria studies made by the Bureau of Mines and other investigators
2. The evaluation of commercially available seismographs of the type used for measuring quarry vibrations
3. A consideration of design criteria for portable seismographs
4. A study of procedures for mounting gages so as to eliminate "ringing"
5. A study of the relative seismic effects from instantaneous, millisecond, and standard delay shooting
6. Accumulation of data for the determination of a propagation law

A Review of Damage Criteria

Several investigators[3] have studied damage to structures from ground borne vibrations from blasting. In a part of these investigations the authors presented a damage criterion; that is, a level of vibration above which damage to structures would result.

At least 3 criteria are in use today, namely:

1. Acceleration
2. Particle Velocity
3. Energy Ratio

The purpose of this study is to ascertain if and how these criteria can be reconciled so as to obtain a collective damage criterion. The 3 seismic quantities that can be measured directly are:

1. Displacement
2. Velocity
3. Acceleration

Hence, the attempt was made to base the criteria on one of these quantities.

In Figure 1 the data from 3 investigations were used to obtain a displacement vs. frequency curve for heavy damage to residential structures. The least-square line through these data has a slope of minus 1.02 and the standard deviation is indicated by the vertical line.

On a displacement vs. frequency chart, displacement has a slope of 0, particle velocity has a slope of minus 1, and acceleration has a slope of minus 2. Thus, the line through the data in

[1] Manuscript completed December 16, 1960 presented at the 44th Annual Convention of the National Crushed Stone Association, Americana, Miami Beach, Florida, January 17-20, 1961
[2] Obert, Dr. Leonard—Seismic Effects from Blasting—Crushed Stone Journal, March 1960, pp 24-27

[3] List of references at the end of this report

Figure 1 has a slope corresponding to particle velocity, and the value of the slope is 7.8 in. per sec. This implies that the best criterion for heavy damage to residential structures is particle velocity, and that the damage level is 7.8 in. per sec. Correspondingly the data for light damage have been considered collectively and the resulting criterion is a particle velocity of 5.0 in. per sec.

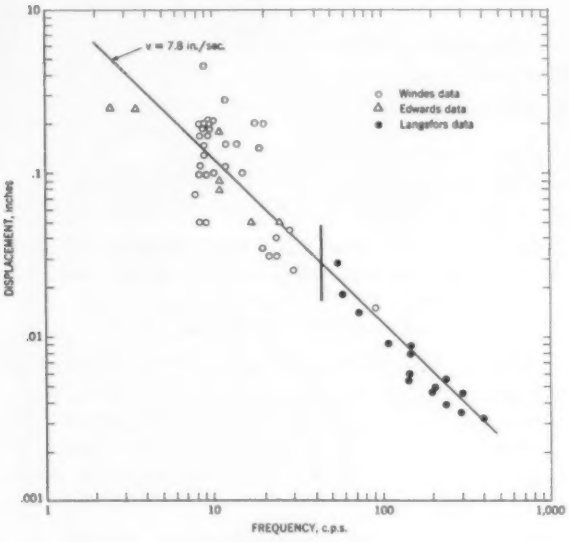


FIGURE 1
Displacement vs Frequency for Major Damage

The complete results of this investigation will be presented in a Bureau of Mines Report of Investigations by Wilbur I. Duvall.

Evaluation of Seismographs

In November 1959, the amplitude and frequency response of 3 self-powered seismographs of the type frequently used for monitoring quarry blasting were checked on the shaking table at the John Carroll University. The analysis of the results showed that this shaking table was not satisfactory for instruments of this size, and the test was repeated at the Naval Research Laboratory on a shaker having a capacity of 5,000 lb force. The seismographs were tested under two conditions:

1. With the instrument (feet) bolted to the shaking table
2. With the instrument sitting unbolted on a No. 2 grit emery paper which was cemented to the shaking table

Each seismograph measured displacement in 3 mutually perpendicular directions, and the response of each component was checked. Table displacements, which were measured with an optical comparator and a displacement meter, ranged from 1 to 25 mills. The table motion was also checked with a 3 component velocity gage.

The analysis of the data from this test is not complete as yet, but some general statements regarding the behavior of these instruments can be made at this time. For an ideal seismograph, the magnification, that is, the ratio of the recorded displacement to the shaking table displacement, should be constant. However, the test showed that the magnification of these instruments depended on both the frequency and the displacement. The results of the test on one of the instruments are shown graphically in Figure 2.

Consider first the vertical component with the instrument unbolted in Figure 2-a. The magnification at 20 and 30 cps was constant over the displacement range, 0 to 22 mills (as indicated by the constant slope of the recorded vs. shaking table displacement curves) and was only slightly greater than the magnification at 10 cps over the same range. At 40 cps the magnification over the range 0 to 10 mills was constant and approximately the same as that at 20 or 30 cps. However, above 10 mills the 40 cps readings became erratic. At 40 cps the acceleration for a displacement of 10 mills is 1.0 g. Hence, above this frequency the unbolted instrument could not remain in contact with the shaking table. The response of the instrument for frequencies above 50 cps was also erratic.

The result from the same instrument bolted to the shaking table is shown in Figure 2-b. For this condition the divergence between the 10 cps, and the 20, 30, and 40 cps curves is greater. The reasons for this are not known. However, the 20, 30, and 40 cps records are linear and have the same slope, indicating a constant magnification. Also, a satisfactory response was obtained at 40 cps for a displacement greater than 10 mills.

The longitudinal records for the same instruments are shown in Figures 2-c and 2-d, for the unbolted and bolted conditions, respectively. For the unbolted condition the 10 and 20 cps curves are linear but indicate different magnifications. However, the 30 and 40 cps records show an abrupt change in slope, which occurred at a displacement level corresponding to 0.4 g in each

case. In the unbolted test it was noted that at about 0.4 g the instrument would start to "walk" on the shaking table. A discussion of the cause of this effect is given in the next section of this report.

The longitudinal component for the bolted condition is given in Figure 2-d. The 10, 20, 30, and 40 cps curves are linear and have very nearly the same slope. Thus, under this condition the instrument is satisfactory in this frequency range.

The other instruments in this test showed similar results. It can be concluded that this type of seismograph is useful for quantitative measurement in the frequency range 0 to 50 cps when the vertical acceleration is less than 1.0 g unbolted, and to about 1.5 g bolted. For the measurement of longitudinal (or transverse) motion the unbolted instruments were satisfactory for an acceleration less than 0.4 g, and the bolted instruments were satisfactory to about 1.5 g. However, this specification presumes that only one type of ground motion is present, that is, either vertical, longitudinal, or transverse motion. For a complex ground motion the acceleration limits would be lower.

It is pointed out that although these instruments do not give a satisfactory response to strong motion, that is, to values of g greater than 0.4, they are useful for the measurement of weak motion. Thus, these instruments are satisfactory for monitoring quarry shots when the acceleration is below the caution range but unsatisfactory for quantitative measurement in the damage range.

The complete details of this test will be given in a Bureau of Mines Report of Investigations.

Design Criteria for Portable Seismographs

The cause of "walking" and other erratic results at high acceleration levels prompted a study of the rigid body motion of portable seismographs. These instruments are usually supported on a 3 point (tripod) mount. Generally, the instrument

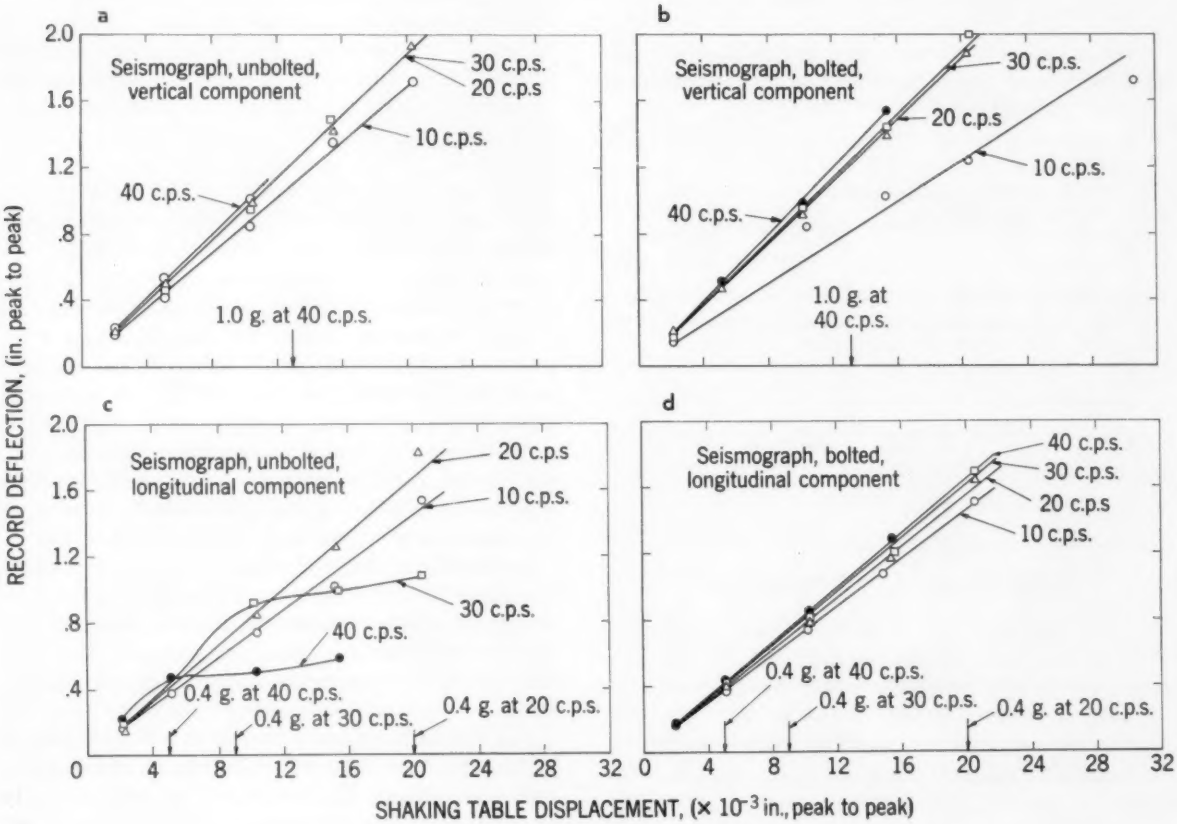


FIGURE 2
Magnification Curves for a Portable Seismograph

is placed (not bolted) on a surface on which vibration level is to be measured. The rigid body motion of a tripod supported seismograph is considered from the point of view that the feet should not slip or leave the surface as a result of imparted motion.

From these studies the following design criteria were deduced:

1. The coefficient of friction between the feet and the surface on which the instrument rests should be as large as possible
2. The center of gravity of the instrument should be vertically above the centroid of the three point mount
3. The vertical distance between the center of gravity of the instrument and the centroid of the feet should be less than the perpendicular distance between the centroid point and any one of the 3 sides of the triangle formed by the feet. Portable seismographs that do not satisfy these conditions should be clamped to the surface if vibration levels above 0.1 g are to be recorded

This study will be reported in the near future in a Bureau of Mines Report of Investigations by Wilbur I. Duvall.

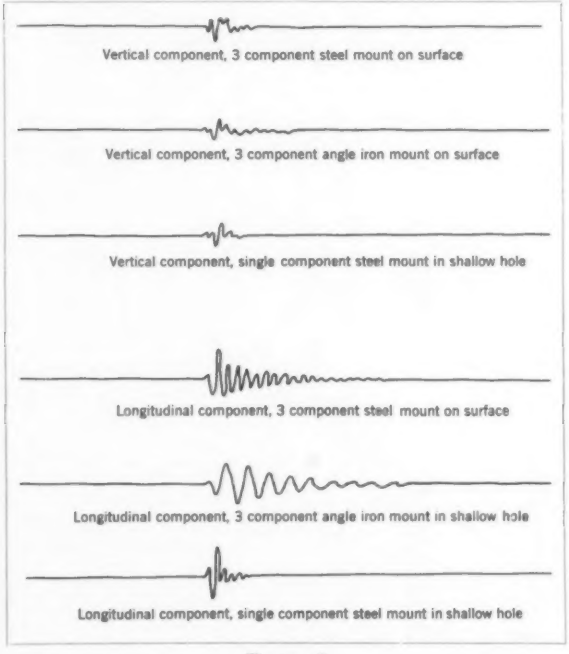

Vertical component, 3 component steel mount on surface
Vertical component, 3 component angle iron mount on surface
Vertical component, single component steel mount in shallow hole
Longitudinal component, 3 component steel mount on surface
Longitudinal component, 3 component angle iron mount in shallow hole
Longitudinal component, single component steel mount in shallow hole

FIGURE 3
Impact Test Records

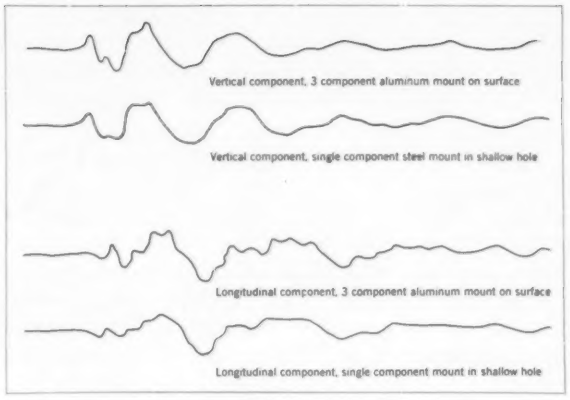

Vertical component, 3 component aluminum mount on surface
Vertical component, single component steel mount in shallow hole
Longitudinal component, 3 component aluminum mount on surface
Longitudinal component, single component mount in shallow hole

FIGURE 4
Quarry Blast Records

Gage Mounting Problem

A preliminary study showed that the method of mounting gages (either velocity or acceleration) on the soil surface affects their response, so that the gage output is not in direct relationship to the ground motion. The mounting, or method of mounting, may cause "ringing," a spurious high frequency vibration, usually of longer duration than the seismic pulse. Usually ringing is stronger in the longitudinal and transverse component than in the vertical component.

To determine a means of eliminating this effect several types of gage mounts and methods of mounting were studied. Three component mounts made from angle iron, steel, aluminum, wood, and a wood box were tested, as well as single component mounts made from steel. These mounts were secured to the soil with a 6 in. pin, normally welded to the mounting plate. In a part of the tests the mount was driven either into the horizontal soil surface or into the sides and bottom of a shallow hole; in the remainder of the tests the mount was buried in a shallow hole.

In Figures 3 and 4 representative records show the effect of both ringing and non-ringing mounts. In Figure 3 the vibration was produced by striking the ground with a rubber hammer; in Figure 4 the vibration was from a conventional quarry shot.

The single component mount shown in Figure 5 when anchored to the sides or bottom of a shallow hole (see Figure 6) was found to give virtually no ringing. This procedure will be used in all subsequent tests.

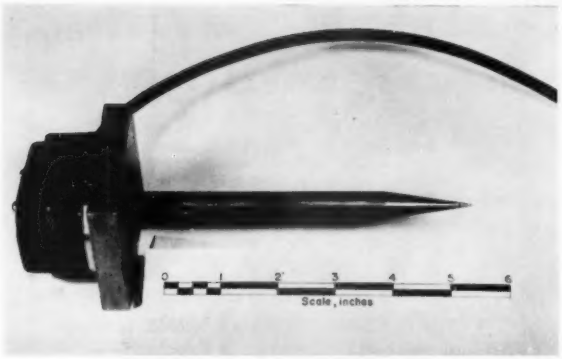


FIGURE 5
Single Component Steel Gage Mount

FIGURE 6
Particle Velocity Gages Mounted in Shallow Holes

Relative Seismic Effects from Instantaneous vs. Millisecond Delay Rounds

Although seismologists have provided some data regarding the relative magnitude of the seismic effects produced by instantaneous vs. millisecond (or longer) delay rounds, these data are not sufficient to evaluate the various parameters involved in quarry blasting. To obtain additional information on this subject a factorial test was designed in which the variables were the delay interval and the number of holes per round. The test was randomized to minimize the effects of the rock variable. A limestone quarry operated by the Weaver Construction Company, Alden, Iowa, was chosen for this test because of the uniformity of the rock and overburden and because the shooting conditions desired could be realized.

Although the reduction of the data has not yet been completed, the results given in Table I are indicative of the cumulative effects from instantaneous vs millisecond delay rounds.

TABLE I

Specification of Round (Explosive per hole equals 200 lb)	Particle Velocity, in. per sec	
	Shot to Gage Dist. = 100 ft	Shot to Gage Dist. = 1,000 ft
7 hole, instantaneous	10	0.5
7 hole, 17 ms delay	6	0.1
7 hole, 34 ms delay	4	0.06
Single hole	4	0.06

These data indicate the following:

1. The largest particle velocity was obtained for the 7 hole instantaneous round. The particle velocity at 100 ft was 10 in. per sec, and at 1,000 ft it was 0.5 in. per sec
2. The next largest effect was obtained for the 7 hole, 17 ms delay round. The particle velocity at 100 and 1,000 ft was, respectively, 0.6 and 0.2 of that for the instantaneous round, indicating that millisecond delays reduce the cumulative effect, and that this reduction increased with distance
3. The 7 hole, 34 ms delay round gave a particle velocity at 100 and 1,000 ft of 0.4 and 0.12 of that for the instantaneous round. Thus, the longer delay further reduced the cumulative effect, and as before, this reduction increased with distance
4. The particle velocity at 100 and 1,000 ft for a single hole shot was the same as that for the 34 ms delay round, indicating that no further reduction in the cumulative effect occurs for delays greater than 34 ms

The final analysis of the results from this test will be complete in February 1961, and a Bureau of Mines Report of Investigations covering this subject will follow.

Determination of a Propagation Law

Besides specifying how the seismic variables (which may be the displacement, particle velocity, or acceleration) vary with the charge size and distance, an adequate propagation law should permit the effect of other parameters, such as the type of explosive or the soil and rock type, to be evaluated. Data from a large number of shots must be obtained to develop an accurate relationship between these variables.

During the year data were obtained from 2 sites. At the Wilson Dam in Alabama 36 shots for the excavation for a new powerhouse were instrumented with up to 24 channels of recording. The purpose of this test was:

1. To check the equipment
2. To determine the frequency range, or spectrum, of the vibration in rock and concrete
3. To monitor the vibration level in an existing power plant and in other nearby parts of the dam structure
4. To collect propagation data

As a "shake down" test the instrumentation was operated under the most adverse conditions possible with respect to both extraneous electrical pickup and moisture.

A number of "bugs" were found and corrected. The vibration level in the existing structures was found to be well below the caution level. The frequency range was considerably above that produced by conventional quarry blasting. High frequency components up to 4,000 cps were present in concrete footings, and components up to 3,300 cps were present in rock. The average frequency was between 75 and 100 cps.

For a number of reasons the propagation law data were not too satisfactory. A lack of control over loading and firing procedures and an inability to measure the seismic response of longitudinal shot-to-gage distances caused difficulties.

The collection of propagation law data from the Weaver Quarry, Alden, Iowa (which were taken simultaneously with the millisecond delay data) was completely satisfactory. The quality of the data from a single hole shot is shown in Figure 7, in which the least square lines for the 3 components of motion, and the standard error (shown by the vertical line) are presented. The curves for the longitudinal and transverse components have the same slope but are displaced from one another; the slope of the curve for the vertical component is less than that for either the transverse or the longitudinal component. This effect has been noted on other shots and is the subject of further study. The data from multihole shots show a somewhat greater spread, but this is expected because at any point the wave from each shot hole may be additive or subtractive depending on their phase relationship./NCSA

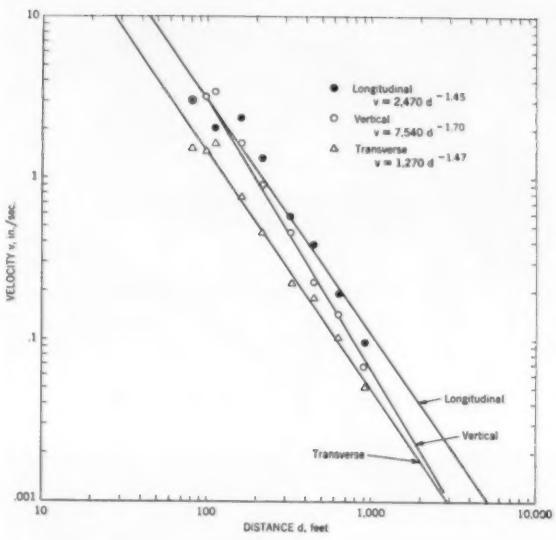


FIGURE 7
Particle Velocity vs Distance for Single Hole Shot

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Highway Needs— Today and Tomorrow

By ERSKINE STEWART
Vice President
Better Highways Information Foundation
Washington, D. C.

HAVE you given any thought to how the people in this great country of ours would react to police regulation prohibiting the use of private automobiles in urban areas during peak hours of traffic?

How would this "America on Wheels" react to a limitation of automobiles, say one to a family, or to the rationing of gasoline to reduce the number of miles each motor vehicle can be driven?

What would be the reaction of the American public to regulations which would keep the people from entering or traveling in certain areas except by mass transit?

I assure you that I have nothing against mass transit. I use it every day. However, a lot of people would not submit to being told where they can go and when and how they should travel.

In other words, are we going to have highways or byways?

In my opinion, only the rank and file of Mr. and Mrs. John Q. Public, through their own understanding and expressed wishes, can make that determination.

The Automotive Age

The Kiplinger magazine, *Changing Times*, in its January issue, carried this observation, in regard to traffic in the 1945-1960 era:

> "Air conditioned, power steered, power braked, no clutch cars swarmed upon the land like the locusts. The two-car garage is no longer the hallmark of the wealthy—now it is the two car carport for millions of families.
>
> "In the cities and suburbs traffic engineers struggle with monstrous tie-ups and traffic jams —dominating everything are the collossal traffic jams the country has got itself into."

Now, let us take a look at what has happened to bring about the situation described by Kiplinger. In 1946, Americans owned 34 1/2 million motor vehicles. Today we own 71 1/2 million cars, trucks, and buses.

If that sounds like a big increase, let us look ahead for just a moment. In another 15 years—by 1976—it is reliably estimated that there will be 114 million motor vehicles trying to use our streets and highways. That is a 63 per cent increase in cars and trucks—44 million more than we now have. But, while motor vehicle registrations are expected to increase by 74 per cent in the 20 years between 1956 and 1976, it is estimated that the number of miles travelled by these vehicles will rise 93 per cent in the same period.

This automotive age and the need for highways to accommodate our cars have come about in our lifetime. In 1900, if all the hard surfaced roads in America were laid end to end, they would not have reached across the mid-state Peninsula of Florida.

Traffic Growth Problems

The coming of the automobile pretty much forced development of hard surfaced roads. Not much was done until the passage of the Federal Aid Road Act of 1916, which launched us into an era of road building—"getting the farmer out of the mud." A very great deal was achieved in the 20's and 30's, when about 14 cents of the automobile transport dollar was spent on roads.

When World War II came along, roads became largely expendable. In the postwar period highway construction lagged far behind the flood of commercial and private traffic. Highway jams and parking crises were accompanied by a growing toll of accidents. Highway deaths reached a total of 40,000 per year, with injuries reaching into millions.

Costs of accidents soared to upwards of $5 billion per year and insurance costs increased to the present equivalent of 18 cents tax per gallon of gasoline used by the average motorist.

Traffic jams in our urban areas became very costly, measured in millions of dollars, and threatened to literally choke off many of our central city areas.

Highway construction was on a piecemeal, crisis to crisis basis, with individual stretches of roads built to meet specific traffic jam problems already existing, and with little or no planning as to how such construction would satisfy future traffic needs.

Federal Aid Highway Act of 1956

In 1956 Congress faced up to the highway requirements of our growing America. The Federal Aid Highway Act of 1956 is probably the most far reaching domestic legislation ever enacted. It was the culmination of years of study, deliberation, and hearings. That Act puts us on the way to accomplishing two principal objectives:

1. Complete by 1972 the National System of Interstate and Defense Highways, 41,000 miles long, built to carry the types and volumes of traffic forecast for 1975
2. Improve all those roadways serving local communities and feeding the interstate defense system. In the latter case, these roads are usually called the ABC system

The ABC system, which consists of farm to market roads, primary and secondary highways, might be compared to the network of blood vessels that serve the main arteries of the human body.

Under the Federal Aid Highway Act, improvements on the ABC system are being financed on a 50-50 federal-state basis. The interstate defense system, which might be considered the main artery, or backbone, of the highway system, is of such tremendous importance to our nationwide, coordinated system of roads, that the federal share of its cost is fixed at 90 per cent, with the states supplying 10 per cent of the cost.

Although the Federal Aid Highway Act of 1956 is only four and a half years old, the accomplishments have been most impressive. One fourth of the interstate defense system is already open to traffic, although additional work is needed on some sections to bring these roads up to 1975 standards.

Physical results are abundantly apparent on every hand. In addition to expedited traffic flow, visible benefits include new industrial developments, commercial centers, and residential areas that better roads have made possible—yes, created.

In the modernization of the ABC roads, contracts have been completed on 106,000 miles and work is now under way on an additional 24,000 for a total of 130,000 miles of local highway improvement under the Act since 1956.

Under the Federal Aid Highway Act of 1956, more than 50,000 construction contracts have been awarded and more than 1 1/2 million people have been directly involved in the operation. The benefit-cost ratio of the program, using only direct benefits, is estimated to be $3 for every $1 spent on these roads.

As to whether taxpayers are getting their money's worth out of this program, let us look at it this way.

Since 1940 the cost index of highway construction has gone up from 100 to just under 223. But the cost of the automobiles which use these roads has risen in the same period from 100 to 241. Yet, we are spending less of our highway transport dollar on highways than we did in the 1920's—12 cents now as compared to 14 cents then.

Benefits of a Modern Nationwide Good Roads System

There are far more benefits to be realized from a modern, nationwide system of good roads of all kinds than we have time to discuss here today. But let us consider just a few of these advantages.

We would all agree that the life saving qualities of modern roadways and reduction in the cost of accidents, in terms of injuries and property losses, are of prime importance. Surveys show that on the interstate system alone, when it is completed, some 4,000 lives will be saved annually.

In one cooperative study conducted by federal and state agencies, it was revealed that accident costs on old highways lacking modern design and up to date engineering principles averaged $82,000 a mile per year.

A modern highway built to interstate standards in the same area used by the same kind of drivers under the same climatic conditions had an accident cost record of $19,000 a mile per year, a difference of $63,000 per mile of highway per year.

Beyond the cost of accidents, additional savings are effected in that vehicle performance and efficiency are greater and operating costs lower on good roads than on poor ones. Vehicle damages, particularly to tires, springs, and alignment, are lower. Savings are realized in terms of tax dollars, since it costs less to build adequate highways than it costs to keep old, worn out roads in usable condition.

Modern highways speed up and expand economic development in areas they serve. This is

manifest by the number of new shopping centers and commercial areas near interchanges on the interstate routes and in other places where highway standards have been improved. New values are created by new roads through the encouragement they offer industry to expand and disperse. This means new business, new jobs, and general prosperity for areas served by new highways.

In New York, for example, it has been estimated that more than $650 million worth of industrial, commercial, and residential development has been attracted to sites along the 538 mile route of the New York Thruway.

Modern highways are necessary for national defense. In time of mobilization or war, a dependable high speed, high capacity road network would be needed to move troops and military equipment. Good roads would be needed to quickly move goods from one processing plant to another, or from raw material sources to production centers. Good roads would be necessary for evacuation purposes or to rush aid to stricken areas.

No other people place such reliance on roads as Americans do. Our whole economy, our national life, is heavily dependent upon the free flowing movement afforded by the road and the automobile. Three out of five Americans go to work by automobile.

Farm crops go to market and supplies reach the farmer over highways. About a third of our school children go to school by bus and another half million are driven in private cars.

Highway Program Crisis

Yet, even with all the advantages that go along with the kind of roads contemplated by the Federal Aid Highway Act, and in spite of the proven need for these roads, we are today faced with a very real threat that our highway program may be seriously slowed down and there is a possibility that we might lose the program altogether.

There are many reasons for the crisis that now faces the road building program. Underlying all these reasons is the widespread lack of public understanding as to the need for and the benefits to be derived from a long range, well planned, soundly financed program of road building.

One of the principal disputes is in the area of financing.

Since it has been proved that the cost of driving on and maintaining poor roads is greater than the cost of building good ones, it goes without saying that the American people can afford the badly needed new roads. Therefore, the financing problem resolves itself principally into the question of how funds for financing these new roads shall be collected.

Unfortunately, there are many organized groups which say they are for good roads, but which also try to shift most of the cost of these roads to other groups or classes of users.

In the final analysis, however, it is the mass of unorganized American motorists who will provide the greatest proportion of the money to build these roads. The problem reduces itself then to: Shall we build these roads with tax monies taken from the general fund, or shall we pay for them with taxes imposed somehow upon all classes of users of these roads?

Another area of dispute about the road building program lies in the matter of design. There are charges that the new roads are being over designed; some say they are under designed.

It has been said that almost everybody knows how to run a hotel or a railroad. We might add to that statement that almost everybody knows how and where to build a highway. But let us remember that the roads built under the Federal Aid Highway Act are being constructed under the first plan ever devised for a nation wide coordinated system of highways. They are engineered with a view not only to present day needs, which might make it seem to some people that they are over designed, but they are being built with a view to the demands that are expected to be made on these roads many years from now.

As to locations for these roads, it is inevitable that disagreements shall arise as to whether they should pass through, over, under, or around the cities and towns they serve. But the people of America should understand that wherever these disputes have arisen in the case of highways already completed, the consequences of the final choice have never been so dire as were predicted, and the over-all benefits of the new highways to the users themselves and the communities they serve have almost always exceeded the predictions of the most optimistic.

Sometimes political pressures have been exerted because the new road would take the back porch off Aunt Nellie's house, or some particularly good land would be absorbed in the right of way. It is

inescapable that inconveniences will be experienced by some when a vast public works project is undertaken.

In the planning of our nation's highways, every effort is made to provide the greatest benefits to the largest number of people with personal dislocation and inconvenience to as few as possible. The laws carry adequate safeguards to protect those whose properties or personal conveniences and interests are disrupted by reason of satisfying the highway needs of all America.

If the public works programs were undertaken only when everybody affected is in complete agreement, or when nobody anywhere is inconvenienced or dislocated, there would be few if any such programs.

One of the most perplexing, and most unfortunate problems contributing to confusion about the highway program lies in the charges of mismanagement, graft, and corruption in the construction of our nation's highways.

The fact is, as I mentioned earlier, that more than 1 1/2 million people have been actively involved in the construction of our highways since the inception of the Federal Aid Highway Act of 1956. Of this number, fewer than 40 people have been involved in all the proven cases of wrongdoing or human error in the program, 1/720th of 1 per cent.

From the standpoint of money, about 1/100th of 1 per cent of the total cost of the program has been involved. Even such a small incidence of wrongdoing as this can not be condoned. But, what private industry can claim such a record for employee dependability and fiscal responsibility?

I have just come from speaking to the Annual Convention of the Associated General Contractors of Iowa in Des Moines. That state is now being rocked by the news that a trusted bank employee, Assistant Cashier with 38 years service, representing 10 per cent of the total number of employees, has embezzled 119 per cent of the assets.

These are just a few of the problems that threaten the completion of the highway program. There are others, but they all lead back to one common fault: Lack of understanding on the part of the public which is already benefiting from the highways completed since enactment of the program in 1956, and who will reap even greater benefits if they can be made more fully aware of the desperate need for this big road program.

Better Highways Information Foundation

It is against this background that the Better Highways Information Foundation has been established. A number of national organizations participating in the road building industry, joined hands in the establishment of the Better Highways Information Foundation.

The Better Highways Information Foundation clings to no particular philosophy as to road building or the factors that must be resolved to keep the federal aid highway program alive, on schedule, and on a sound financial footing.

The BHIF stands for one thing and one thing only: *Better Highways NOW*. It is the belief of the Foundation that if the opinion leaders of America and our citizens at the grass roots level are properly informed and provided with factual information as to the needs for and the benefits to be derived from a nation wide system of modern roadways of all kinds, they will provide the necessary demand for our lawmakers to rise above partisan difficulties and provide the necessary solutions for carrying out the objectives of the Federal Aid Highway Act.

Since the BHIF program is aimed at grass roots America, it was necessary that state and local supporters and affiliates be secured for carrying the wonderful story of better highways into every corner of America.

BHIF Educational Program

Since last July, an interim educational program has been conducted by the Foundation.

Last month the major program of the BHIF went into high gear. Two hundred pages of program materials and program guides have been mailed to BHIF representatives all over the United States. Supplements to this kit will follow at regular intervals.

In addition, the following program materials are in varying stages of production, and some of these items will be ready for distribution within a few days:

1. Slide illustrated speeches
2. Traveling exhibits for use at conventions, fairs, trade shows, and other large meetings
3. Posters for exhibits at smaller meetings, and for use as car cards, window displays, and for other purposes
4. TV film strips
5. Editorial cartoons

6. At least two more comprehensive brochures
7. A motion picture
8. Newspaper and magazine articles for placement at the national level

And many, many other items, all of which are designed for adaptation at local levels for telling the story of better highways.

We are now in the "Year of Decision," the year when our national highway program either is put on a sound financial basis and permitted to proceed as planned in the Federal Aid Highway Act of 1956, or is allowed to falter due to inadequate financing.

Industry as represented by the equipment manufacturers, material producers, private engineering firms, and contractors believed Congress when in the 1956 Act it expressed a desire and an intent to complete the 41,000 mile interstate system in all states in 13 years or as close thereto as practicable.

The states also believed Congress and in many instances took steps to increase highway income to insure their ability to meet the stepped up matching fund requirements. The officials and industry leaders alike applauded the sound, long-range program. To them it meant economy and efficiency made possible by guaranteed continuity —no more feast and famine nor peaks and valleys. Industry accepted the idea as a challenge and proceeded to meet that challenge.

I would again make it abundantly clear that the BHIF is not a lobbying organization. There are, in the national organizations from whom the Foundation's principal support is drawn, adequate machineries for properly attending to legislative activity in connection with the highway program.

BHIF's Main Purpose

The job of the Foundation is to develop, produce, and distribute factual information on our highway needs, beaming our program to grass roots America with the firm conviction that when the public is properly informed, the necessary demands will be raised for a long range, well planned, fiscally sound program of highway construction.

Without that demand the highways will not be built and America on wheels will become a stationary population.

The Foundation needs the help of all responsible organizations and agencies in this job. For failure to do the job, and loss of the highway program is a loss America can not afford./NCSA

44th Annual Convention

(Continued from Page 12)

The evening's entertainment featured a variety of unusual and unique acts. Performing before the startled gaze of the many guests was Roy LeRoy who wandered from table to table demonstrating his ability to eat fire. Ron and Eva Reyes delighted the dinner guests with their clever interpretation of a bullfight, followed by the Don Strawn Group of accomplished limbo dancers and the nationally known guitarist Joe Sodja who found a most receptive audience for his wonderful talent.

"A Night in the Tropics" was truly a fitting climax to the social functions of this sucessful Convention.

Final Session

On Friday, January 20, newly elected NCSA President Charles Coburn presided over the General Session which marked the close of the Convention. The first speaker was Carl A. Carpenter, Assistant Chief, Division of Physical Research, U. S. Bureau of Public Roads, whose opinions and findings regarding "Federal Inspection on the Interstate System" are of vital importance to every crushed stone producer. Next on the program was Erskine Stewart, Vice President, Better Highways Information Foundation. "Highway Needs —Today and Tomorrow" was the title of his talk which will be found as one of the articles in this issue of the *Crushed Stone Journal.* Last, but by no means least, the final speaker, Dr. Herbert True, talked about obtaining "Profit From Ideas on Your Job." Dr. True's method of presentation was completely unique and his thought provoking comments will long be remembered.

As the presiding officer rapped his gavel signifying adjournment until 1962, resounding applause filled the room in appreciation of the importance and significance of the Convention program and the excellence of the many speakers./NCSA

Manufacturers Division
National Crushed Stone Association

•

These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

•

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Division of Koehring Co.
1210 Kenton St., Springfield, Ohio
Drills, Drilling Equipment — Rotary, Churn

Canadian Industries Ltd.
P. O. Box 10, Montreal, Quebec, Canada
Explosives, Blasting Supplies

Cape Ann Anchor & Forge Co.
P. O. Box 360, Gloucester, Mass.
Drop Balls

Chain Belt Co.
P. O. Box 2022, Milwaukee 1, Wis.
Bearings; Bin Gates; Bins; Buckets — Elevator; **Castings** — Iron, Alloy Iron; **Chains; Conveyors** — Belt, Apron, Chain, Drag, Flight, Vibrating; **Elevators; Feeders; Grizzlies; Pillow Blocks; Plant Design and Layout; Plants; Pumps; Screens** — Vibrating, Shaking, Revolving

Church, H. F., Inc.
P. O. Box 72, Farmington, Conn.
Drilling — Contract

Clark Equipment Co.
Construction Machinery Division
P. O. Box 599, Benton Harbor, Mich.
Bulldozers, Scrapers, Elevating Graders; Loaders — Tractor; **Shovels, Draglines, Cranes, Clamshells; Tractors** — Truck

Contractors and Engineers Magazine
470 Park Ave., South, New York 16, N. Y.
Publications — Trade

Cross Perforated Metals Plant
National-Standard Co.
P. O. Box 507, Carbondale, Pa.
Screen Sections — Plate; **Screens** — Vibrating, Shaking, Revolving

Cummins Engine Co., Inc.
1000 Fifth St., Columbus, Ind.
Engines — Diesel

Deister Machine Co.
1933 East Wayne St., Fort Wayne 4, Ind.
Classifiers; Screens — Vibrating, Shaking, Revolving; **Washing Equipment**

Diamond Iron Works
Division Goodman Manufacturing Co.
Halsted St. and 48th Place, Chicago 9, Ill.
Belts — Conveyor, Elevator; **Bins; Buckets** — Elevator; **Conveyors** — Belt; **Crushers** — Jaw, Roll, Hammermills; **Feeders** — Apron, Plate; **Plant Design and Layout; Plants; Screens** — Vibrating, Shaking, Revolving; **Washing Equipment**

Differential Co.
P. O. Box 238, Findlay, Ohio
Cars — Mine. Quarry: **Locomotives; Trucks, Trailers, Truck Bodies**

Dixon Supply Co.
3104 Fourth Ave., South, Birmingham 5, Ala.
Conveyors — Belt

Drill Carrier Corp.
P. O. Box 628, Salem, Va.
Drills, Drilling Equipment, Supplies

Du Pont of Canada Ltd.
85 Eglinton Ave., East, Toronto 12, Ontario, Canada
Explosives, Blasting Supplies

Manufacturers Division – National Crushed Stone Association
(continued)

Du Pont, E. I., de Nemours & Co.
Wilmington 98, Del.
Explosives, Blasting Supplies

Dustex Corp.
25 Anderson Road, Buffalo 25, N. Y.
Dust Control Equipment; Feeders

Eagle Crusher Co., Inc.
900 Harding Way East, Galion, Ohio
Bins; Buckets — Elevator; **Conveyors** — Belt; **Crushers, Pulverizers; Feeders; Loaders** — Bucket; **Plant Design and Layout; Plants; Screens** — Revolving

Eagle Iron Works
P. O. Box 934, Des Moines 4, Iowa
Castings — Iron, Alloy Iron; **Classifiers; Drop Balls; Washing Equipment**

Easton Car & Construction Co.
Easton, Pa.
Cars — Mine, Quarry; **Trailers, Truck Bodies** — Off Highway

Edwards Engineering Co., Inc.
9 Parker Ave., Meriden, Conn.
Belts; Buckets — Elevator; **Car Shakeouts; Clutches; Consulting Engineers; Feeders; Motors** — Electric; **Pillow Blocks; Plant Design and Layout; Plants; Scales; Screen Sections** — Wire Cloth; **Screens** — Vibrating, Shaking, Revolving; **Speed Reducers; Testing Sieves and Shakers; Welding Equipment and Supplies**

ESCO Corp.
1017 Griggs St., Danville, Ill.
Buckets — Clamshell, Dragline; **Castings** — Manganese, Alloy Steel; **Chains; Dippers** — Shovel; **Steel** — Alloy, Carbon

Ensign-Bickford Co.
660 Hopmeadow St., P. O. Box 308, Simsbury, Conn.
Blasting Supplies

Euclid Division
General Motors Corp.
1361 Chardon Road, Cleveland 17, Ohio
Bulldozers, Scrapers, Elevating Graders; Loaders — Tractor; **Tractors; Trucks, Trailers, Truck Bodies** — Off Highway

Frog, Switch & Mfg. Co.
Manganese Steel Dept.
Carlisle, Pa.
Castings — Manganese; **Dippers** — Shovel; **Screen Sections** — Plate

Gardner-Denver Co.
South Front St., Quincy, Ill.
Air Compressors; Bits — Rock; **Drills, Drilling Equipment, Supplies; Pumps**

General Electric Co.
Locomotive & Car Equipment Dept.
2901 East Lake Road, Erie 1, Pa.
Electrical Apparatus — Motors, Generators, Control Rectifiers; **Locomotives** — Diesel Electric, Electric, Battery; **Trucks** — Off Highway

Gill Rock Drill Co., Inc.
P. O. Box 251, Lebanon, Pa.
Bits — Rock; **Drills, Drilling Equipment, Supplies**

Gilson Screen Co.
110 Center St., Malinta, Ohio
Testing Sieves and Shakers

Goodrich, B. F., Industrial Products Co.
500 South Main St., Akron 18, Ohio
Belts; Hose; Tires, Tubes

Goodyear Tire & Rubber Co.
Akron 16, Ohio
Batteries; Belts; Hose; Tires, Tubes

Manufacturers Division – National Crushed Stone Association
(continued)

Gulf Oil Corp.
Gulf Bldg., 710 Main Street, Houston 2, Texas
Batteries; Lubricating Oils, Greases, Gasoline, Diesel Fuels; Tires, Tubes

Harnischfeger Corp.
4400 West National Ave., Milwaukee 46, Wis.
Engines — Diesel; **Hoists** — Drum; **Power Generating and Distributing Systems; Shovels, Draglines, Cranes, Clamshells; Welding Equipment and Supplies**

HarriSteel Products Co.
420 Lexington Ave., New York 17, N. Y.
Screen Sections — Wire Cloth

Heidenreich, E. Lee, Jr.
Consulting Engineers
75 Second St., Newburgh, N. Y.
Consulting Engineers; Plant Design and Layout

Hendrick Manufacturing Co.
Carbondale, Pa.
Buckets — Elevator; **Grating; Screen Sections** — Plate; **Screens** — Vibrating, Shaking, Revolving

Hercules Powder Co.
Wilmington 99, Del.
Explosives, Blasting Supplies

Hetherington & Berner, Inc.
701-745 Kentucky Ave., Indianapolis 7, Ind.
Asphalt Plants; Dryers — Aggregate; **Feeders**

Hewitt-Robins Incorporated
666 Glenbrook Road, Stamford, Conn.
Bearings; Belts; Bin Gates; Bins; Buckets — Elevator; **Car Pullers; Car Shakeouts; Classifiers; Conveyors** — Belt, Wire; **Crushers, Pulverizers; Elevators; Feeders; Hoists** — Drum; **Hose; Indicators** — Bin Level; **Pillow Blocks; Plant Design and Layout; Plants; Screen Sections; Screens** — Vibrating, Shaking, Revolving; **Speed Reducers; Vibrators** — Bins and Chutes; **Washing Equipment**

Hoyt Wire Cloth Co.
P. O. Box 1577, Lancaster, Pa.
Bucker-Up Strips — Rubber; **Screen Sections** — Wire Cloth

Hughes Tool Co.
P. O. Box 2539, Houston 1, Texas
Bits — Rock; **Drills, Drilling Supplies**

Ingersoll-Rand Co.
11 Broadway, New York 4, N. Y.
Air Compressors; Bits — Rock; **Blowers and Fans; Drills, Drilling Equipment, Supplies; Engines** — Diesel, Gasoline; **Hoists** — Drum; **Hose; Pumps**

International Harvester Co.
Construction Equipment Division
P. O. Box 270, Melrose Park, Ill.
Bulldozers, Scrapers, Elevating Graders; Engines — Diesel, Gasoline; **Loaders** — Tractor; **Tractors** — Crawler, Truck; **Trucks, Trailers, Truck Bodies**

Iowa Manufacturing Co.
916 16th St., N. E., Cedar Rapids, Iowa
Asphalt Plants; Belts — Conveyor, Elevator; **Bins; Classifiers; Conveyors** — Belt; **Crushers, Pulverizers; Dryers** — Aggregate; **Dust Control Equipment; Feeders; Grizzlies; Plant Design and Layout; Plants; Screen Sections; Screens** — Vibrating, Shaking, Revolving; **Washing Equipment**

Jaeger Machine Co.
550 West Spring St., Columbus 16, Ohio
Air Compressors; Hoists — Drum; **Pumps**

Jaques Bros. Ltd.
Griffiths and Palmer Sts., Richmond, Victoria, Australia
Crushers, Pulverizers; Elevators; Feeders; Plants; Screens — Vibrating, Shaking, Revolving; **Shovels, Draglines, Cranes, Clamshells**

Manufacturers Division – National Crushed Stone Association
(continued)

Jeffrey Manufacturing Co.
815 North Fourth St., Columbus 16, Ohio
Bin Gates; Blowers and Fans; Buckets — Elevator; **Car Pullers; Chains; Clutches; Conveyors** — Belt, Apron, Vibrating, Screw, Bucket, Slat; **Crushers, Pulverizers; Dryers** — Aggregate; **Elevators** — Bucket; **Feeders; Grizzlies; Indicators** — Bin Level; **Locomotives; Pillow Blocks; Screens** — Vibrating, Shaking, Revolving; **Vibrators** — Bins and Chutes; **Washing Equipment**

Joy Manufacturing Co.
333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.
Air Compressors; Bits — Rock; **Blowers and Fans; Car Pullers; Conveyors** — Belt, Idlers; **Drilling** — Contract; **Drills, Drilling Equipment, Supplies; Dust Control Equipment; Hoists** — Drum

Kennedy Van Saun Mfg. & Eng. Corp.
405 Park Ave., New York 22, N. Y.
Bins; Blowers and Fans; Buckets — Elevator; **Castings** — Iron, Alloy Iron; **Classifiers; Conveyors** — Belt, Apron, Pneumatic; **Crushers, Pulverizers; Dryers** — Aggregate; **Elevators; Feeders; Pillow Blocks; Plant Design and Layout; Plants; Screens** — Vibrating, Shaking, Revolving; **Washing Equipment**

Kensington Steel Division
Poor & Co., Inc.
505 East Kensington Ave., Chicago 28, Ill.
Buckets — Elevator; **Castings** — Manganese, Alloy Steel; **Chains; Conveyors** — Drag; **Crushers, Pulverizers** (Parts); **Elevators; Feeders** (Parts); **Screen Sections** — Plate; **Shovels, Draglines, Cranes, Clamshells** (Parts); **Tractors** — Crawler (Parts)

Koehring Division
Koehring Co.
3026 West Concordia Ave., Milwaukee 16, Wis.
Buckets — Clamshell, Dragline; **Dippers** — Shovel; **Loaders** — Bucket; **Shovels, Draglines, Cranes, Clamshells; Trucks, Trailers, Truck Bodies** — Off Highway

Lecco Machinery & Engineering Co.
New Airport Road, Bluefield, W. Va.
Conveyors — Vibrating; **Feeders; Screens** — Vibrating, Shaking; **Vibrators** — Bins and Chutes

LeTourneau-Westinghouse Co.
2301 North Adams St., Peoria, Ill.
Bulldozers, Scrapers, Elevating Graders; Tractors — Rubber Tired; **Trucks, Trailers, Truck Bodies** — Off Highway; **Wire Rope and Related Products**

Link-Belt Co.
300 West Pershing Road, Chicago 9, Ill.
Bearings; Belts; Bin Gates; Bins; Buckets — Clamshell, Dragline; **Buckets** — Elevator; **Car Pullers; Car Shakeouts; Castings** — Iron, Alloy Iron; **Chains; Classifiers; Clutches; Conveyors** — Belt; **Dippers** — Shovel; **Dryers** — Aggregate; **Elevators; Feeders; Grizzlies; Pillow Blocks; Plant Design and Layout; Plants; Screen Sections** — Plate; **Screens** — Vibrating, Shaking, Revolving; **Shovels, Draglines, Cranes, Clamshells; Speed Reducers; Vibrators** — Bins and Chutes; **Washing Equipment**

Lippmann Engineering Works, Inc.
4603 West Mitchell St., Milwaukee 14, Wis.
Bin Gates; Bins; Classifiers — Sand; **Conveyors** — Flite; **Crushers; Elevators** — Belt, Chain; **Feeders** — Apron, Reciprocating; **Plants; Screens** — Vibrating, Roller; **Washing Equipment**

Ludlow-Saylor Wire Cloth Co.
4333 West Clayton Ave., St. Louis 10, Mo.
Screen Sections — Wire Cloth

Mack Trucks, Inc.
1355 West Front St., Plainfield, N. J.
Tractors — Trucks; **Trucks**

Manganese Steel Forge Co.
Richmond St. and Castor Ave.,
Philadelphia 34, Pa.
Bin Gates; Bins; Castings — Manganese, Alloy Steel; **Screen Sections; Screens** — Vibrating, Shaking, Revolving

Marion Power Shovel Co.
Division of Universal Marion Corp.
617 West Center St., Marion, Ohio
Dippers — Shovel; **Shovels, Draglines, Cranes, Clamshells**

Manufacturers Division – National Crushed Stone Association
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Marsh, E. F., Engineering Co.
4324 West Clayton Ave., St. Louis 10, Mo.
Bin Gates; Buckets — Elevator; **Conveyors** — Belt, Portable, Steel Apron; **Elevators; Feeders; Plant Design and Layout; Plants**

McLanahan & Stone Corp.
252 Wall St., Hollidaysburg, Pa.
Castings — Iron, Alloy Iron; **Classifiers; Clutches; Crushers, Pulverizers; Elevators; Feeders; Grizzlies** — Roller; **Pillow Blocks; Plants; Screens** — Vibrating, Shaking, Revolving; **Washing Equipment**

Meissner Engineers, Inc.
300 West Washington St., Chicago 6, Ill.
Consulting Engineers; Plant Design and Layout

Mission Manufacturing Co.
P. O. Box 4209, Houston 14, Texas
Bits — Rock; **Drills, Drilling Equipment; Pumps**

Murphy Diesel Co.
5317 West Burnham St., Milwaukee 19, Wis.
Engines — Diesel; **Power Generating and Distributing Systems; Welding Equipment and Supplies**

New Jersey Drilling Co., Inc.
Box 251, Route 206, Netcong, N. J.
Drilling — Contract

Nordberg Manufacturing Co.
3073 South Chase Ave., Milwaukee 1, Wis.
Castings — Manganese, Alloy Steel; **Crushers, Pulverizers; Engines** — Diesel; **Feeders; Grizzlies; Hoists** — Drum; **Power Generating and Distributing Systems; Screens** — Vibrating, Shaking, Revolving

Northern Blower Division
Buell Engineering Co.
6409 Barberton Ave., Cleveland 2, Ohio
Blowers and Fans; Classifiers; Dust Control Equipment — Filter Bag, Electrical Precipitators, Mechanical Cyclone

Northwest Engineering Co.
135 South LaSalle St., Chicago 3, Ill.
Shovels, Draglines, Cranes, Clamshells

Olin Mathieson Chemical Corp.
Energy Division
East Alton, Ill.
Explosives, Blasting Supplies

Pennsylvania Crusher Division
Bath Iron Works Corp.
323 South Matlack St., West Chester, Pa.
Crushers, Pulverizers

Pettibone Mulliken Corp.
4710 West Division St., Chicago 51, Ill.
Buckets — Clamshell, Dragline; **Castings** — Manganese Steel; **Dippers** — Shovel; **Loaders; Pumps**

Pioneer Engineering
Division of Poor & Co., Inc.
3200 Como Ave., Minneapolis 14, Minn.
Asphalt Plants; Bin Gates; Bins; Classifiers; Conveyors — Belt; **Crushers, Pulverizers; Dryers** — Aggregate; **Dust Control Equipment; Elevators; Feeders; Plant Design and Layout; Plants; Screen Sections; Screens** — Vibrating, Shaking, Revolving; **Washing Equipment**

Pit and Quarry Publications, Inc.
431 South Dearborn St., Chicago 5, Ill.
Publications — Trade

REICHdrill Division
Chicago Pneumatic Tool Co.
6 East 44th St., New York 17, N. Y.
Air Compressors; Bits — Rock; **Drills, Drilling Equipment, Supplies; Engines** — Diesel; **Hoists** — Drum; **Hose; Pneumatic Tools; Power Generating and Distributing Systems; Pumps**

Rock Products
79 West Monroe St., Chicago 3, Ill.
Publications — Trade

Manufacturers Division – National Crushed Stone Association
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Rogers Iron Works Co.
11th and Pearl Sts., Joplin, Mo.
Bins; Castings — Iron; **Classifiers** — Screw, Paddle; **Conveyors** — Belt, Pan; **Crushers, Pulverizers; Drills** — Jumbo; **Drop Balls; Elevators** — Bucket; **Feeders** — Apron, Reciprocating, Belt; **Grizzlies** — Vibrating, Roll; **Hoists** — Mine; **Plants; Screens** — Vibrating, Revolving; **Washing Equipment**

Schramm, Inc.
West Chester, Pa.
Air Compressors; Bits — Rock; **Drills, Drilling Equipment, Supplies; Pneumatic Tools**

Screen Equipment Co., Inc.
40 Anderson Road, Buffalo 25, N. Y.
Screens — Vibrating

Simplicity Engineering Co.
Durand, Mich.
Car Shakeouts; Conveyors — Pan; **Feeders** — Vibrating; **Grizzlies; Screen Sections; Screens** — Vibrating

Smith Engineering Works
Division Barber-Greene Co.
P. O. Box 723, Milwaukee 1, Wis.
Belts — Conveyor, Elevator; **Bin Gates; Buckets** — Elevator; **Classifiers** — Sand; **Conveyors** — Belt; **Crushers; Elevators** — Bucket; **Feeders** — Reciprocating, Apron; **Grizzlies; Plant Design and Layout; Plants; Screens** — Vibrating, Revolving; **Washing Equipment**

Spencer Chemical Co.
610 Dwight Bldg., Kansas City 5, Mo.
Explosives, Blasting Supplies

Stedman Foundry & Machine Co., Inc.
P. O. Box 209, Aurora, Ind.
Crushers, Pulverizers — Cage Disintegrators, Hammermills; **Screens** — Vibrating

Sturtevant Mill Co.
103 Clayton St., Dorchester, Boston 22, Mass.
Crushers, Pulverizers; Separators — Air

Taylor-Wharton Co.
Division Harsco Corp.
High Bridge, N. J.
Buckets — Elevator; **Castings; Chains; Conveyors** — Apron; **Dippers** — Shovel; **Drop Balls; Feeders; Screen Sections; Welding Equipment and Supplies**

Thew Shovel Co.
East 28th St. and Fulton Road, Lorain, Ohio
Loaders — Wheel; **Shovels, Draglines, Cranes, Clamshells**

Thor Power Tool Co.
175 North State St., Aurora, Ill.
Belts; Bits — Rock; **Drills, Drilling Equipment, Supplies; Dust Control Equipment; Hoists** — Drum; **Hose; Motors** — Electric; **Pneumatic Tools; Power Generating and Distributing Systems; Pumps**

Timken Roller Bearing Co.
Service-Sales Division
1835 Dueber Ave., S. W., Canton 6, Ohio
Bearings — Tapered Roller; **Bits** — Rock; **Steel** — Alloy

Torrington Co.
Bantam Bearings Division
3702 West Sample St., South Bend 21, Ind.
Bearings

Traylor Engineering & Manufacturing
Division of Fuller Co.
Allentown, Pa.
Air Compressors; Blowers and Fans; Conveyors — Pneumatic; **Crushers, Pulverizers; Dryers** — Aggregate; **Dust Control Equipment; Feeders; Indicators** — Bin Level; **Plant Design and Layout**

Manufacturers Division – National Crushed Stone Association
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Trojan Powder Co.
17 North Seventh St., Allentown, Pa.
Explosives, Blasting Supplies

Tyler, W. S., Co.
3615 Superior Ave., N. E., Cleveland 14, Ohio
Screen Sections — Wire Cloth; **Screens** — Vibrating, Shaking, Revolving; **Testing Sieves and Shakers; Vibrators** — Bins and Chutes; **Washing Equipment**

Universal Engineering Corp.
Subsidiary of Pettibone Mulliken Corp.
625 C Ave., N. W., Cedar Rapids, Iowa
Asphalt Plants; Bin Gates; Bins — Portable, Semi-Portable; **Conveyors** — Belt, Pan, Apron; **Crushers, Pulverizers** — Jaw, Roll, Impact, TwinDual Roll, Hammermills; **Elevators** — Bucket, Belt; **Feeders** — Wobbler, Pan, Apron, Vibrating; **Grizzlies; Plant Design and Layout; Plants; Screens** — Vibrating, Shaking, Revolving; **Washing Equipment**

Varel Manufacturing Co.
9230 Denton Drive, Dallas 20, Texas
Bits — Rock

Vibra-Tech Engineers, Inc.
407 Hazleton National Bank Bldg., Hazleton, Pa.
Seismological Instruments, Surveys

Vibration Measurement Engineers, Inc.
725 Oakton St., Evanston, Ill.
Seismological Instruments, Surveys

Webb, Jervis B., Co.
8951 Alpine Ave., Detroit 4, Mich.
Chains; Conveyors — Belt, Apron, Drag, Flight; **Elevators** — Bucket; **Feeders; Plant Design and Layout; Plants**

Werco Steel Co.
2151 East 83rd St., Chicago 17, Ill.
Buckets — Clamshell, Dragline, Elevator; **Castings** — Manganese, Alloy Steel; **Chains; Conveyors** — Belt; **Crushers, Pulverizers; Dippers**—Shovel; **Drop Balls; Screen Sections; Wire Rope and Related Products**

Western-Knapp Engineering Co.
50 Church St., New York 7, N. Y.
Consulting Engineers

White Motor Co.
842 East 79th St., Cleveland 1, Ohio
Batteries; Engines — Gasoline; **Power Generating and Distributing Systems; Tractors** — Truck; **Trucks, Trailers, Truck Bodies**

White Motor Co.
Autocar Division
Exton, Pa.
Trucks, Trailers, Truck Bodies

Wickwire Spencer Steel Division
Colorado Fuel & Iron Corp.
575 Madison Ave., New York 22, N. Y.
Screen Sections — Wire Cloth; **Screens** — Vibrating, Shaking, Revolving; **Wire Rope and Related Products**

Williams Patent Crusher & Pulverizer Co.
2701-2723 North Broadway, St. Louis 6, Mo.
Bins; Classifiers; Crushers, Pulverizers; Feeders; Screens — Vibrating; **Separators** — Air

Wiss & Associates
Division of Engineers Collaborative
570 Northwest Highway, Des Plaines, Ill.
Consulting Engineers; Seismological Instruments, Surveys

NATIONAL CRUSHED STONE ASSOCIATION
NCSA
1918